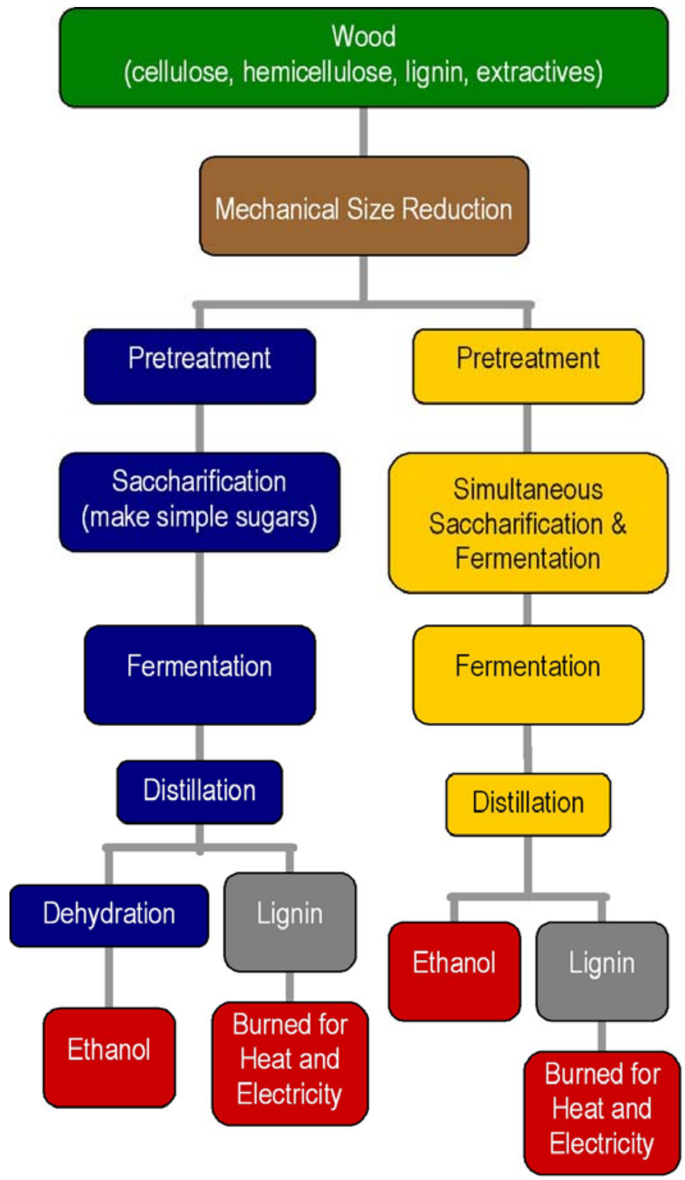
Woody Biomass for Energy in Michigan

TOPICS FOR DISCUSSION AND INQUIRY

BY BILL COOK AND CHRIS SAFFRON, MICHIGAN STATE UNIVERSITY

EXTENSION BULLETIN E-3090
JANUARY 2010

Emerging Technologies in Wood Energy



Wood can already be used to produce heat and electricity using established technologies of District Energy and Combined Heat and Power plants. Using wood to make transportation fuels and chemicals on a commercial scale may not be too far into the future. Making cellulosic ethanol is an example of producing second-generation fuels. Several biochemical and thermochemical processes have the potential to break wood into smaller molecular structures and recombine those structures to form an array of useful products. Large sums of money, from both the U.S. government and private ventures, have been invested to explore and commercialize advanced energy processes.

Cellulose and hemicellulose are large, complex sugar molecules that make up most of what we call wood. The most common elements of these complex sugars are carbon, oxygen, and hydrogen. These elements are also the building blocks of gasoline, plastic, and a range of chemicals. Several processes have been identified in laboratories and some have been staged up to demonstration and pilot projects. The global race for the first commercial-sized project is under way.

Biochemical Processes

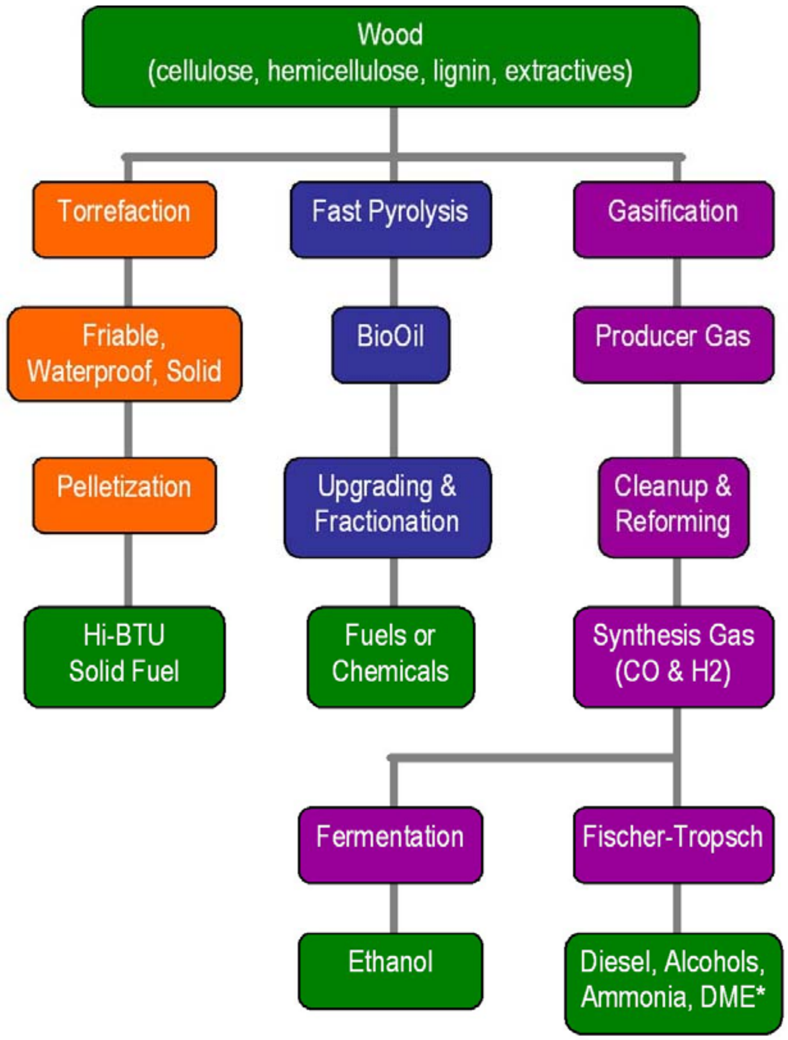
Biochemical processes use chemistry and microbes to produce ethanol. Wood is mechanically broken down into small pieces and then pretreated. Possible pretreatments include the use of dilute acids, ammonia fiber expansion, steam explosion, organo-solvents, ammonia recycle percolation, calcium hydroxide, and others. The pretreated material is then hydrolyzed. Hydrolysis is a chemical reaction using water to separate molecules. In this case, it makes simple sugars (saccharification) from complex cellulose and hemicellulose molecules. The simple sugars are then fermented to produce a solution called a beer. A one-stage biochemical process combines saccharification and fermentation in a single step. The beer is then distilled, producing ethanol. Distilled ethanol is then dehydrated (water removed) to produce transportation-grade fuels. Lignin and other wood-derived by-products are burned to produce heat and electricity.

Thermochemical Processes

Thermochemical processes employ heat, usually with little or no oxygen present, to produce ethanol and chemicals. Torrefaction, fast pyrolysis, and gasification technologies are being explored at the same time as the biochemical processes.

Torrefaction uses a relatively low temperature in an oxygen-deprived environment to produce wood that is hydrophobic (repels water) and has more energy per unit weight. The process is used in North America to produce solid wood products such as flooring and siding. In Europe, torrefaction has been explored to produce an improved wood pellet or briquette. The lighter and water-repellent pellet may result in significant savings in storage, packaging, and transportation costs.

Fast pyrolysis uses higher temperatures in an oxygen-deprived environment to render a **bio-oil**, which can be further processed into a wide range of transportation fuels and/or chemicals. Fast pyrolysis units are not necessarily large. Portable units may be able to be set up in the field. The bio-oil can be economically transported much farther than raw wood products, so there may be some practicality in moving pyrolysis to the field rather than wood to the pyrolysis plant.



* DME: Dimethel Ether, a transportation fuel and fuel additive

Gasification uses even higher temperatures and high pressure to produce gases from wood. These gases are then cleaned and reformed to manufacture **syngas** or synthetic gas. The syngas can then be further processed to produce a range of transportation fuels and chemicals.

References:

Bergman, Richard and John Zerbe. 2004. Primer on Wood Biomass for Energy. USDA Forest Service, State and Private Forestry Technology Marketing Unit, Forest Products Laboratory. Madison, Wisconsin. 10 p.

Union of Concerned Scientists. 2006. Clean Energy: How Biomass Energy Works. Available at: *www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-biomass-energy-works.html*.

MICHIGAN STATE UNIVERSITY EXTENSION

Prepared by Michigan State University Extension
Upper Peninsula Tree Improvement Center, 6005 J Road, Escanaba, MI 49829 906-786-1575
For more information on MSU initiatives, visit the Office of Biobased Technologies at www.bioeconomy.msu.edu